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Defining Metropolitan Areas and the Rural-Urban Continuum

A Comparison of Statistical Areas Based on County and Sub-County Geography

John Cromartie
Linda Swanson

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Abstract

Accurate analysis of the economic and social problems currently facing urban and rural residents, as well as the implementation of programs to address them, depend to a large degree on how settlement is measured. County-based statistical areas misrepresent settlement patterns in parts of the Nation with large counties and limit our ability to track and analyze the geographical restructuring of U.S. population. Criteria currently used to delineate metro and nonmetro areas, and a more detailed county-level, rural-urban continuum, are applied to sub-county data in three States that represent different problems with county-level measurement of settlement patterns. Comparing the resulting sub-county areas with county-level areas shows significant improvement both in the territorial delineation of metro areas and in the classification of population in different types of nonmetro areas. The sub-county system delineates the interstitial space where a metro area ends and the hinterland begins, which is important at a time when central cities are losing their gravitational pull on surrounding metro territory.

Keywords: metropolitan areas, rural-urban continuum, settlement patterns

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Summary

Counties are too large in many parts of the Nation to serve as building blocks for statistical areas used to analyze changing settlement patterns. The research reported here replaces counties with sub-county units used to identify metro and nonmetro components of a five-level "rural-urban continuum." The sub-county system not only brings greater detail to different settlement types within the nonmetro portion of the Nation, but also delineates the interstitial space where metro areas end and the hinterland begins. Understanding the patterns of this interstitial space in different regions of the country is critical at a time when central cities are losing their gravitational pull on surrounding metro territory.

Our system of measurement, designed to contribute to the Office of Management and Budget's "Metro 2000" project, contains three essential attributes: (1) using data at a sub-county level; (2) holding constant the current rules defining metro areas; and (3) incorporating that metro definition into a five-level, rural-urban continuum, based on existing coding schemes developed at USDA's Economic Research Service. The continuum categories used here are: (1) metro core; (2) metro outlying; (3) nonmetro, adjacent to metro; (4) nonmetro, nonadjacent, with city; and (5) nonmetro, nonadjacent, without city.

After comparing the relative merits of four sub-county geographical units for which census data are available, we chose census tracts because they are large enough to have acceptable sampling error rates, are consistently defined across the Nation, are usually subdivided as population grows to maintain geographic comparability over time, and can be aggregated to form county-level statistical areas when needed. We selected three States--Arizona, Minnesota, and South Carolina--as initial case study areas for this project. They exhibit different problems with county-level measurement of settlement patterns and each State also includes the full range of rural-urban settlement types.

The tract-level continuum more precisely identifies divisions along the rural-urban continuum than is possible with county geography, from the largest cities to open country. In the tract continuum, not only is the territorial delineation of metro areas more accurately depicted than in the county continuum, but nonmetro populations living in a wide spectrum of settlement types are more clearly identified. For researchers and policy makers who work with the entire range of settlement types, a rural-urban continuum is crucial and the choice of geographic units affects both the accuracy of the continuum and the ability to apply the system to a diverse set of problems. The current metro system can be improved by including all of the Nation's territory via a rural-urban continuum and by using geographical units that are small enough to adequately define settlement.

patterns. The goal of this research is to lay the groundwork for devising statistical areas that reflect the diversity of rural settlement patterns. It will be achieved by replacing counties with sub-county units as basic geographic building blocks used to identify components of the rural-urban continuum.

The need to go below the county level has become especially acute given the increasing integration of the rural economy with the U.S. and world economy dominated by large, urban centers; the employment and residential growth in suburban nodes; and the growing complexity of the rural-urban frontier (Alonso 1992, Berry 1995). According to Alonso, it is necessary

> ...to begin a process of rethinking the human geography of well-to-do nations... The existing censal categories are misleading because they present a vision of the United States as a territory tiled with convex, continuous, mutually exclusive types of regions, while the reality is one of a great deal of interpenetration, much of it rather fine-grained (pp. 25-26).

Although a problem for all regional analysts, county geography has been particularly limiting for researchers studying the rural hinterland. At one extreme, such hinterland in the Northeast is integrated economically and socially with the urban complex along the Eastern seaboard. At the other extreme, rural territory in the Great Plains has fewer large, urban centers with which to be integrated, and is organized in a different way, with smaller cities of economic and social activity scattered throughout. County units are unevenly suited to measure such differences in settlement and rural/urban integration patterns. In general, the more western the State, the more territory the counties encompass. Particularly when these larger counties are used as the unit of measurement, metro boundaries stretch far beyond the actual influence of the urban core, obscuring the State's settlement pattern.

The Office of Management and Budget (OMB, the agency responsible for delineating Metropolitan Statistical Area standards) and the U.S. Bureau of the Census have undertaken a research initiative to develop alternative approaches to defining urban and rural areas. The growing complexity of U.S. settlement patterns prompted this evaluation with the view to developing a more accurate system for the start of the new century. Among the tasks being addressed are the following:

> ...devis[e] a system that would explicitly define both metropolitan and nonmetropolitan areas, a system that would include all of the Nation's territory...

> ...Present the fundamental geographic unit(s) or "building block(s)" that would be used in identifying the geographic entities of the settlement system...
>
> ...Discuss the nature of the criteria by which the geographic building blocks would be aggregated to create statistical areas... (Dahmann and Fitzsimmons 1995, pp. 2-4).

As part of a project called "Metro 2000," OMB commissioned four reports by outside experts who were asked to devise alternative statistical systems accounting for all U.S. territory (Adams 1995, Berry 1995, Frey and Speare 1995, Morrill 1995). In the four resulting systems, one retained counties as the fundamental building block (Adams), two used sub-county geography (Berry, Frey and Speare), and one opted for both county and sub-county units (Morrill). All four reports proposed changing criteria for defining settlement that is currently termed metro by OMB, with two differing in fundamental ways (Adams, Frey and Speare) and two retaining major elements of the metro/nonmetro dichotomy as currently defined (Berry, Morrill).

The research reported here draws on the Economic Research Service's (ERS) considerable experience with rural population and territory to add to the discussion of the best system to measure national settlement patterns. The essential elements of the system we designed are: (1) using data at the sub-county level; (2) holding constant the current criteria defining metropolitan areas; and (3) incorporating that metro definition into a five-category composite of the two ERS rural-urban continuums. We applied our system in three States chosen to represent disparate county sizes and types of settlement. The areas thus defined by using sub-county geography were mapped and compared with the same five-category system using county geography. This approach isolates the effect of switching to sub-county building blocks on the land area, population size, and population characteristics of metro areas and other components of the rural-urban continuum. The results provide a solid base of information from which to evaluate and recommend alternative approaches to representing the U.S. settlement system.

Determining the Appropriate Sub-County Unit

Sub-county units that could serve as the basic building blocks for delineating the rural-urban continuum include block groups, census tracts/block numbering areas (tracts, for short), minor civil divisions, and ZIP Code areas. Block groups are the most detailed, dividing the country into 229,000 units. There are approximately 62,000 tracts, 40,000 ZIP Code areas, and 35,000 minor civil divisions. Before

1990, data for rural areas were not available for block groups and tracts, and mapping at the sub-county level was limited. The introduction of the TIGER system, a nationwide digital map database produced by the Bureau of the Census during the 1980's, provided the tools necessary to work at this more detailed level.

Basic population numbers are available for all four choices. Commuting data, a key to any delineation scheme, are based on a sample of the U.S. population. Although population thresholds for the other three choices are high enough to provide reliable commuting flows in most areas (Frey and Speare, 1995, pp.168-171), estimates at the block-group level contain sampling error rates that are too high, eliminating them from consideration.

Consistency of population size for geographic units is important in order to measure population density. Tracts are statistical subdivisions of counties that contain an average of 4,000 people and are subdivided whenever the population increases above a certain threshold. ZIP Code areas also have built-in population thresholds and are subdivided or reconfigured as need arises. Minor civil divisions are not defined consistently nationwide and vary greatly in population size, making their use less than ideal.

A strong case has been made in favor of 5-digit ZIP Code areas as the appropriate spatial unit (Berry, 1995, pp. 93-103). ZIP code areas have the following desirable qualities: (1) small enough to capture evolving settlement patterns; (2) consistently defined nationwide; (3) structured to allow for intercensal updates of relevant information; and (4) used as a data and mapping unit by public and private groups employing a variety of data collection techniques. Except for (4), these attributes apply equally to census tracts.

After eliminating block groups and minor civil divisions as possible choices, we chose tracts over ZIP Code areas for several reasons. They give us greater geographic detail and more accurate reporting of census data, especially for the crucial commuting information. Currently, ZIP Codes do not work as well as tracts as repositories of census data, because they do not match up with the hierarchical spatial units (blocks, block groups, tracts, counties) that are used to collect and report census data. Data that is tied to more than one place, such as commuting flows which connect place of work with place of residence, exacerbate this problem. Discussions are underway to improve the accuracy of future ZIP-Code-based census data (Berry, 1995, p. 94).

In addition, ZIP Code areas are sometimes reconfigured rather than subdivided in response to rapid population growth, introducing geographical instability to a system using ZIP-Code areas. The Census Bureau makes every effort to subdivide

tracts in response to population growth, so that they can be aggregated for comparisons over time.

Intercensal population estimates and other demographic data are now available at the tract level. However, particularly between the censuses, data are often collected by States and local organizations at the county level. As sub-county units, census tracts can be aggregated to a county unit to make use of county data.

The Rural-Urban Continuum

ERS researchers measuring the spectrum of settlement types in the United States have approached the problem by expanding the metro/nonmetro dichotomy. Two coding schemes, the original, 10-level Rural-urban Continuum Code (Butler and Beale, 1994) and an alternative, 9-level system called the Urban Influence Code (Ghelfi and Parker, 1995) have been devised (see appendix table 1). Counties in the metro category are broken down by size of metro area and whether the county is an outlying or core component. Counties in the nonmetro category are broken down by adjacency to a metro area and either size of urban or largest-city population. In both schemes, the subdivisions of the OMB-defined metro and nonmetro categories form a settlement continuum based on population size, population density, levels of urbanization, commuting patterns, and adjacency. To facilitate cartographic and statistical comparisons of county- and tract-based delineations, we created an abridged, five-level composite of the above coding schemes to form the rural-urban settlement continuum used in our analysis:

(1) **Metro core**. Every metro area begins with an Urbanized Area, a statistically derived unit that describes the extent and distribution of the built-up area. For both counties and tracts, if 50 percent or more of the unit's population is contained in the Urbanized Area, it is included as part of the metro core.

(2) **Metro outlying**. Once a set of core units is established, nearby counties or tracts are examined to determine whether a "high degree of economic and social integration" exists with the core; commuting flows to and from the core (the number commuting in either direction as a percentage of resident workers) are used to measure integration, but in addition, units are required to show some degree of "metropolitan character" as measured by population density, percent urban, and population growth during the previous decade.

(3) **Nonmetro adjacent.** For both county-level and tract-level versions of the rural-urban continuum, adjacent units are those that are physically adjacent to a metro area and have at least 2 percent of the employed labor force commuting to the metro core.

All other nonmetro units fall into one of two nonadjacent categories:

(4) **Nonmetro nonadjacent with city.** This category includes all units that are not adjacent to metro areas but contain all or part of a city of 10,000 or more residents.

(5) **Nonmetro nonadjacent without city.** The final category contains units that are both nonadjacent to metro areas and without a city of 10,000 or more residents.

Data and Study Areas

All data except commuting flows were taken from STF1A and STF3A machine-readable files for the 1990 decennial census. Place-of-work data from the 1990 census was used by the Census Bureau to construct a special tabulation for this project, consisting of a tract-to-tract matrix of commuting flows covering the entire Nation.[3]

We selected three States, Arizona, Minnesota, and South Carolina, as initial case study areas for this project. Each State includes the full range of rural-urban settlement types but is located in a region that contains unique settlement patterns and physical county sizes.

Regional differences emerge based on rural population density, urban population size and structure, and differences in the geographic building blocks themselves. Counties and tracts are larger and therefore less detailed in Western States such as Arizona where population is sparse. Rural areas in the South contain larger populations that are more evenly distributed across the landscape, with smaller sized geographic units. Minnesota and South Carolina differ markedly in terms of their urban settlement structure; the former is dominated by one large metro

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[3]The tract-level commuting flows matrix can be obtained from the Census under the file name STP154. Because commuting data were processed before all street address ranges were coded into the Census Bureau's digital cartographic database, many tracts, particularly those in nonmetro areas, have a high proportion of allocated journey-to-work data. This analysis is based on commuting in and around metro areas, where allocation rates are relatively low. Interpretation of any results from this data should take into account the allocation rates, computable from the file.

region (Minneapolis-St. Paul) with a handful of small centers located mostly near the borders of the state; the latter exhibits a more evenly distributed system made up of several medium sized metro centers. Both Minnesota and South Carolina have 31 percent of their population currently classified in the county-based system as nonmetro, while only 15 percent of Arizona's population is nonmetro. Comparisons of settlement patterns among all three States come into clearer focus when current criteria for delineating the rural-urban continuum are applied to tracts.

Findings

County-based and tract-based rural-urban classifications for the three selected states are shown in figures 1-6. Appendix figures 1-3 indicate the location of cities that are discussed below. County-based metro boundaries are highlighted on the tract-based maps to offer points of reference. In all cases, significant reconfiguration of the continuum takes place with the switch to tracts. County-based classifications mask an evolving settlement structure that comes into sharp focus in the tract-based schemes.

Arizona

In Arizona, county-based metro core counties cover 19 percent of the State's territory. The precise locations of the central cities of Phoenix, Tucson, and Yuma are well hidden (compare figure 1 with appendix figure 1), and Tucson and Yuma have no outlying component identified. Mohave County in the northwest corner of the State is classified as an outlying component of the Las Vegas, Nevada, metro area. Nonmetro nonadjacent counties without a city are confined to a narrow band in the east and one county on the western border.

All of sizeable Coconino County, including most of the Grand Canyon, was classified as nonadjacent with a city in 1990 because Flagstaff is located at the southern edge of the county. In June 1995, Flagstaff became a metro central city, making Coconino County a metro core county. In addition, Kane County, Utah was brought in as a metro outlying county.[4]

Arizona's metro regions appear much more constricted and have different shapes on the tract-based map (figure 2). All metro regions now have outlying

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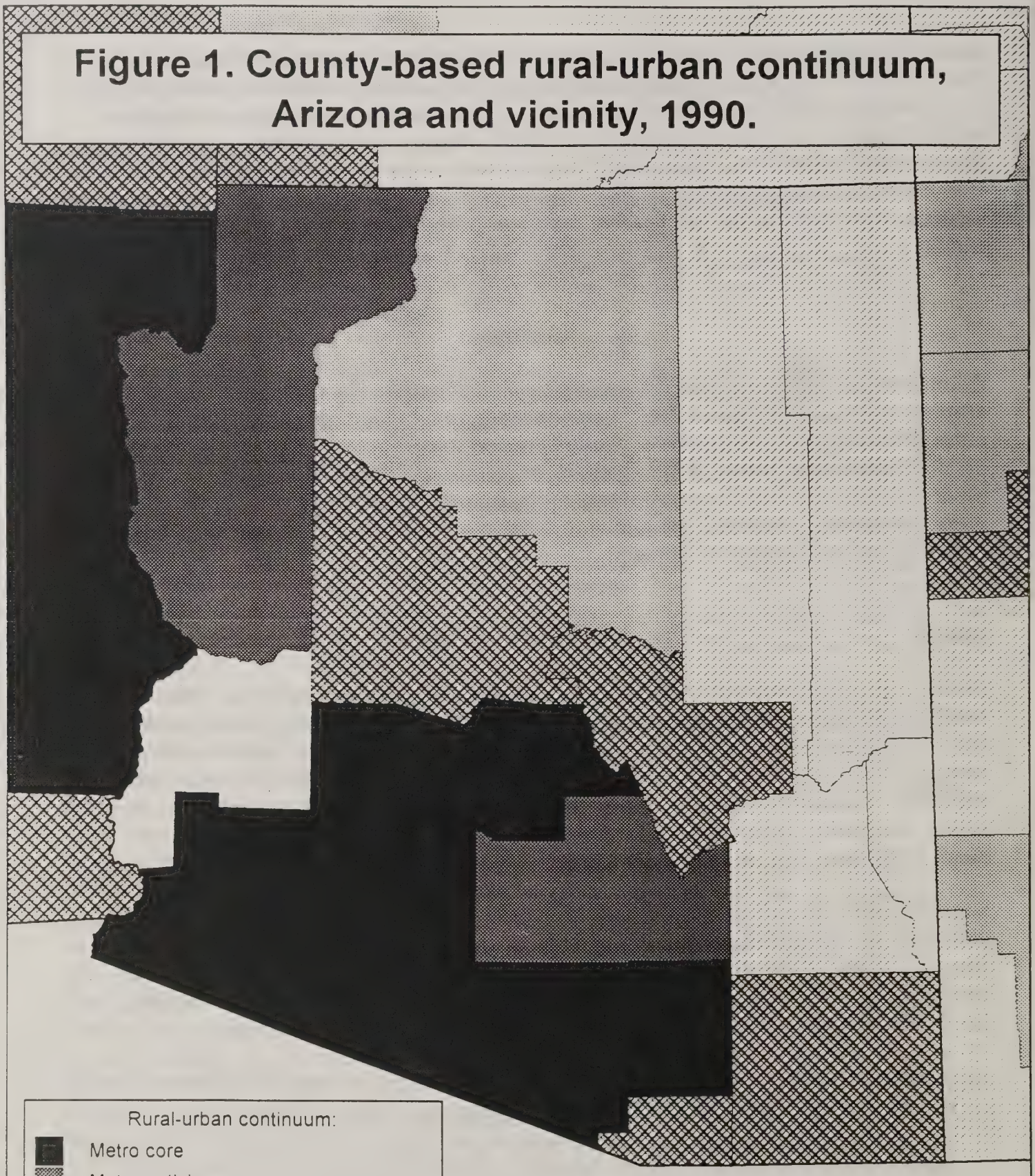
[4]We did not include this change so that the maps consistently reflect 1990 conditions. Flagstaff became a metro area due to post-1990 population growth.

Figure 1. County-based rural-urban continuum, Arizona and vicinity, 1990.



Produced by Rural Economy Division, Economic Research Service, U.S. Dept. of Agriculture, using data from the Bureau of the Census, U.S. Dept. of Commerce

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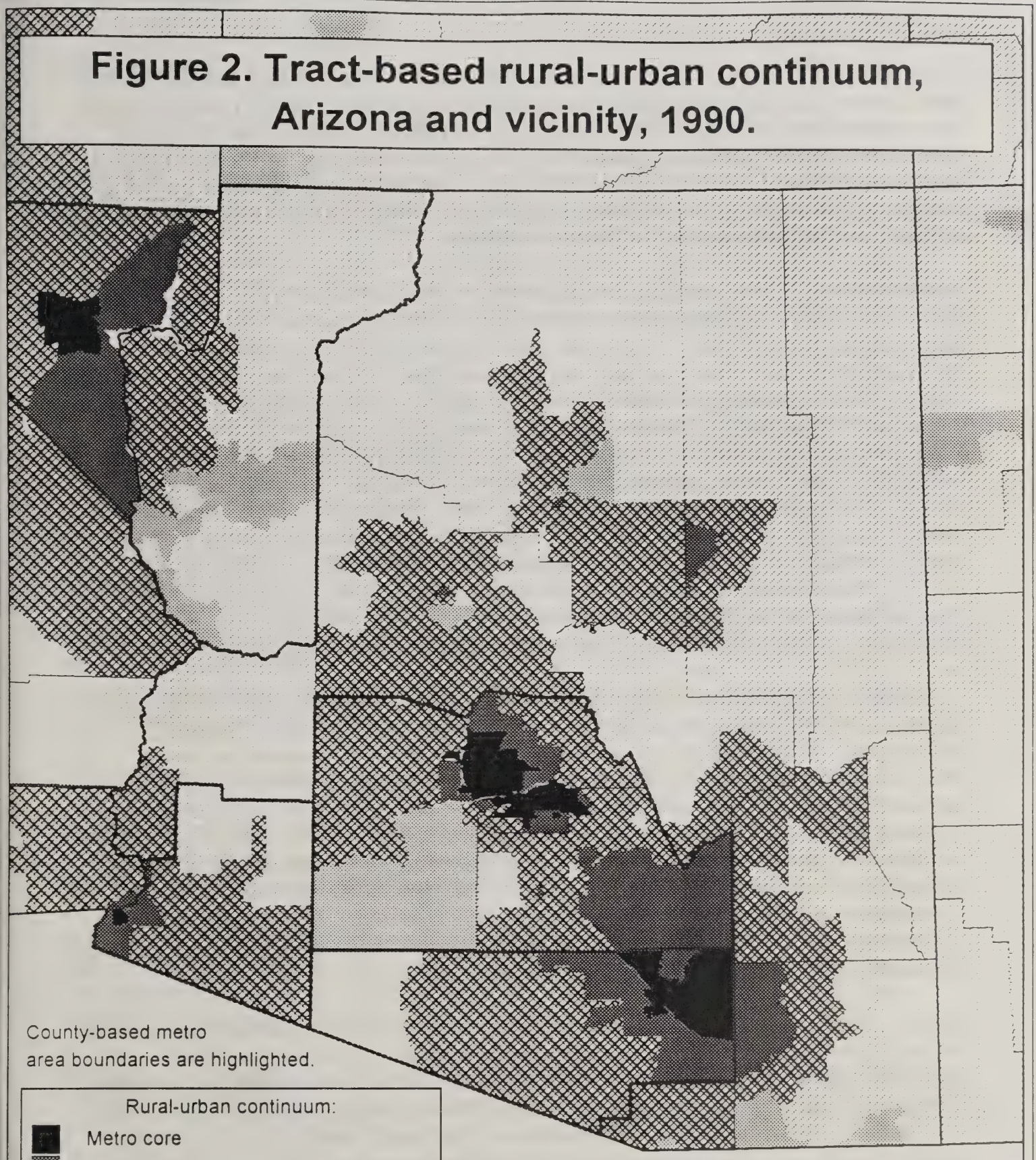
Figure 2. Tract-based rural-urban continuum, Arizona and vicinity, 1990.



Produced by Rural Economy Division, Economic Research Service, U.S. Dept. of Agriculture, using data from the Bureau of the Census, U.S. Dept. of Commerce

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components. Territory taken up by metro cores drops from 19 to 2 percent of the State's total. Central city locations are visible, for instance Yuma's position on the Colorado River in a corner of its home county. Phoenix takes up less than one-sixth of its original two-county area. Tucson is almost as large at the tract level but is reshaped and in a substantially different location, taking up just a corner of its original one-county area and extending into two other counties that were originally not included in the Tucson metro area.

Most noticeable is the complete change in metro status for Mohave County. No part of the county has significant commuting to Las Vegas when commuting is measured at the tract-level. It had been included as part of the county-based metro area because of commuting from Bullhead City, Arizona, to the small city of Laughlin, Nevada (see appendix figure 1). Laughlin is in the same county as Las Vegas and is thus part of the county-based metro core to which commuting is measured, but it is 75 miles south of Las Vegas and is not part of the metro core at the tract level. Kane County, Utah, in the newly formed Flagstaff metro area, is a second example of designating an outlying metro county based on commuting that is not to the central core city; in this case the commuting is mostly to Page, Arizona, which is more than 115 miles away from Flagstaff but in the same county. The inclusion of Mohave and Kane Counties as part of the Las Vegas and Flagstaff metro areas, respectively, clearly demonstrates the poor fit of many large counties to an area's settlement pattern, especially in the fast-growing West.

A number of tracts located some distance from Phoenix's metro core are classified as metro outlying areas, including tracts in Prescott, Winslow, and Flagstaff, which were nonmetro cities in the county-based system. These result from a small number of workers commuting, possibly on an irregular basis, from Phoenix to these outlying tracts, not from commuting into the metro core. These areas, in turn, create a large amount of nonmetro adjacent territory that would otherwise be nonadjacent. Adjustments in the criteria are needed to avoid including far-flung tracts that are not economically and socially integrated with the metro core. In other cases, the existence of noncontiguous, metro outlying tracts rests on commuting to the metro core from bedroom communities or significant commuting from the metro core to peripheral employment centers.

Several nonmetro cities with populations above 10,000 emerge within nonadjacent territory that had previously been hidden within metro outlying or nonmetro adjacent counties, including Prescott and Kingman in the north and Nogales, Sierra Vista, and Douglas along the Mexican border. Nearly three times as much territory is classified as nonadjacent with a city in the tract-based version relative to the county-based version. Nonadjacent territory without a city is found throughout the State on the tract-based map and covers twice the territory as it does on the county-based version.

Minnesota

In Minnesota, with smaller counties and a single, dominant metro region, the continuum from metro core to nonmetro nonadjacent is visible at the county level (figure 3). However, Minneapolis-St. Paul is not territorially the largest metro area at the county level; that distinction belongs to Duluth-Superior which encompasses St. Louis County in the northeast as well as Douglas County, Wisconsin. Counties spatially misrepresent other metro centers, especially Grand Forks and Fargo-Moorhead, as well as nonmetro, nonadjacent cities such as Bemidji, Fergus Falls, and Brainerd. No large, unbroken districts of nonmetro nonadjacent territory exist at the county level.

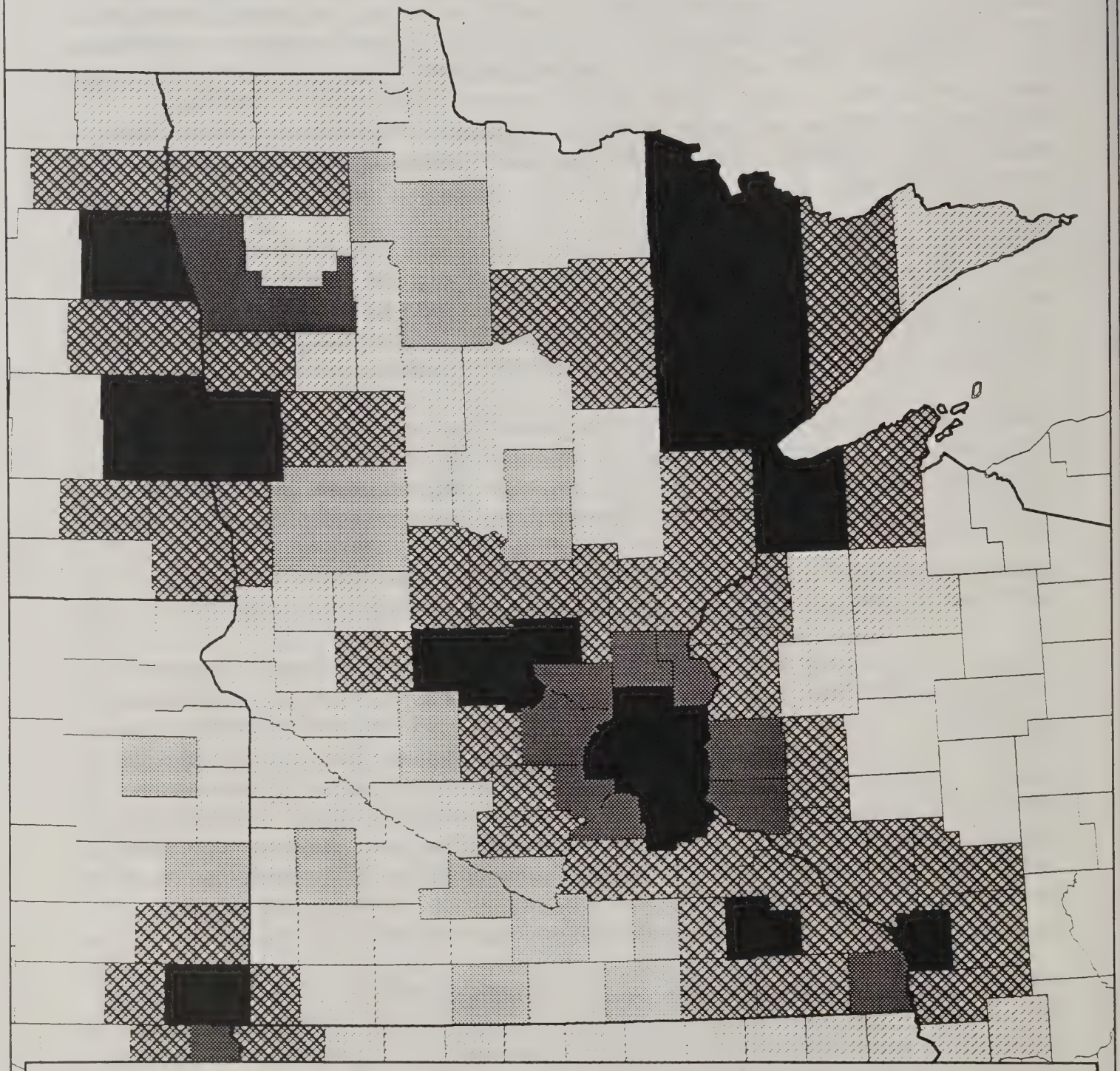
Figure 4 shows that the territorial extent of tract-based metro areas in Minnesota, as in Arizona, is a fraction of those found in county-based versions. Metro territory drops from 21 percent of the State total down to 8 percent; metro cores drop from 15 to 2 percent. Tracts more accurately depict Minneapolis-St. Paul as the State's dominant metro area, in areal extent as well as population size.

Many of Minnesota's metro areas contain some discontinuous outlying portions embedded within nonmetro adjacent areas, illustrating Alonso's rural-urban "interpenetration" concept. As in Arizona, these outliers are either employment centers to which workers from the core are commuting or bedroom communities surrounded by nonmetro areas less integrated with the core, or both. Most of the county-based metro areas, including Minneapolis-St. Paul, contain the range of settlement types from metro core to nonmetro nonadjacent without a city.

Adjacent areas appear as transition zones around each metro area, in a sense anticipating their future expansion. Tract-based adjacent areas cover much less of the State than the county-based version (17 versus 28 percent). In some areas, such as around Minneapolis-St. Paul, the adjacency band may be too narrowly defined; the requirement of physical adjacency leaves out several tracts whose commuting patterns indicate heightened levels of urban influence. Nonetheless, adjacent tracts identify the rapidly growing, interstitial space where metro areas blend into the nonmetro hinterland. Tract-based measurement enables a clearer delineation of this rapidly changing convergence zone, allowing us to track the location of emerging employment centers on the outskirts of metro areas.

Nonadjacent areas with cities are also much more constricted at the tract level (5 percent of the land area versus 13 percent at the county level), while nonmetro nonadjacent areas without cities nearly double in size with the switch to tracts. This latter settlement type becomes territorially dominant in all parts of the State except the southeast. The remote, sparsely populated conditions found

Figure 3. County-based rural-urban continuum, Minnesota and vicinity, 1990



Produced by Rural Economy Division, Economic Research Service, U.S. Dept. of Agriculture, using data from the Bureau of the Census, U.S. Dept. of Commerce

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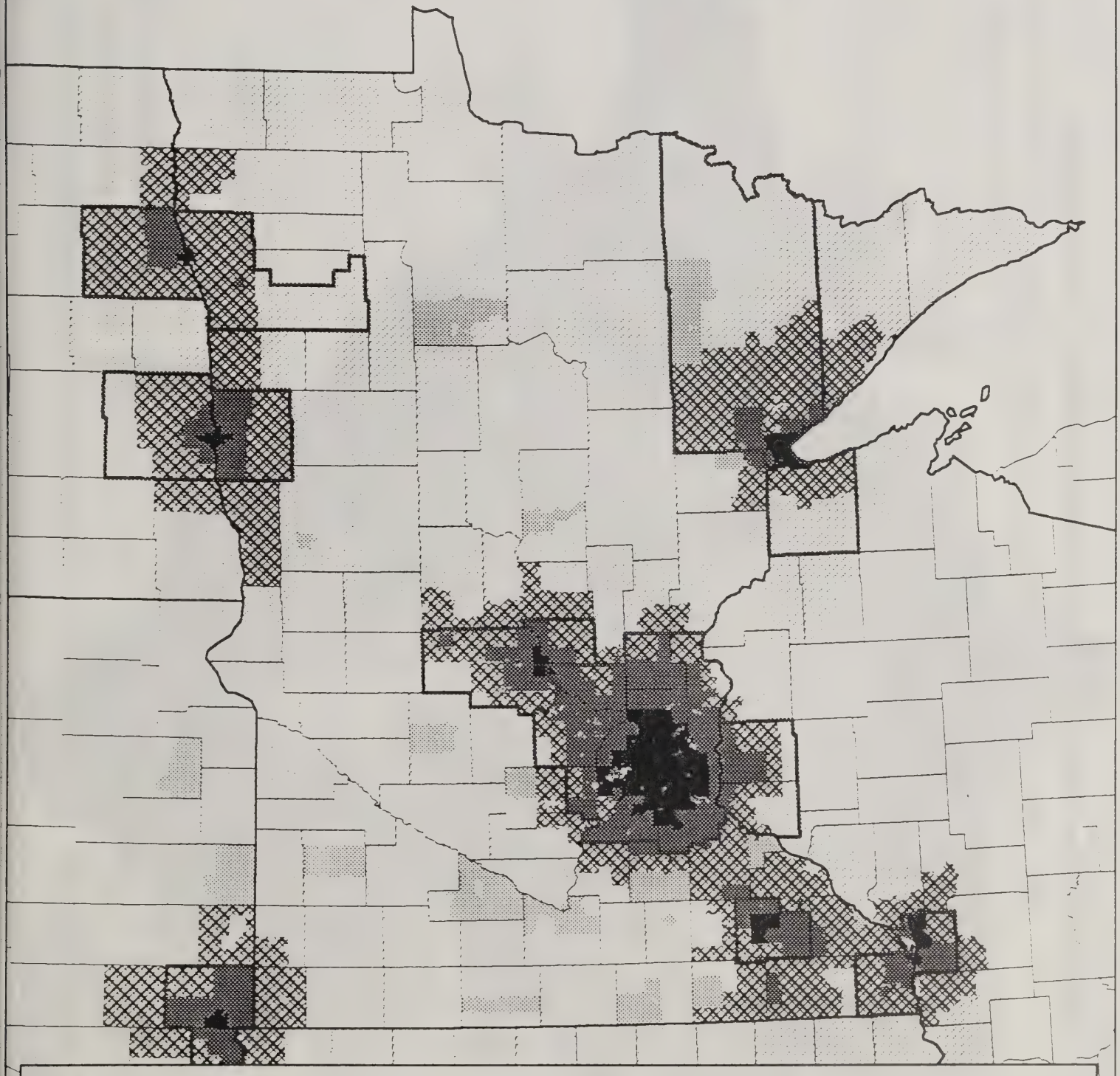
Figure 4. Tract-based rural-urban continuum, Minnesota and vicinity, 1990.



Rural-urban continuum:

- Metro core
- Metro outlying
- Adjacent with 2% commuting to core
- Nonadjacent with city of 10,000+
- Nonadjacent without city of 10,000+

County-based metro area boundaries are highlighted.

Miles

0 50 100

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Produced by Rural Economy Division, Economic Research Service, U.S. Dept. of Agriculture, using data from the Bureau of the Census, U.S. Dept. of Commerce.

Figure 5. County-based rural-urban continuum, South Carolina and vicinity, 1990.

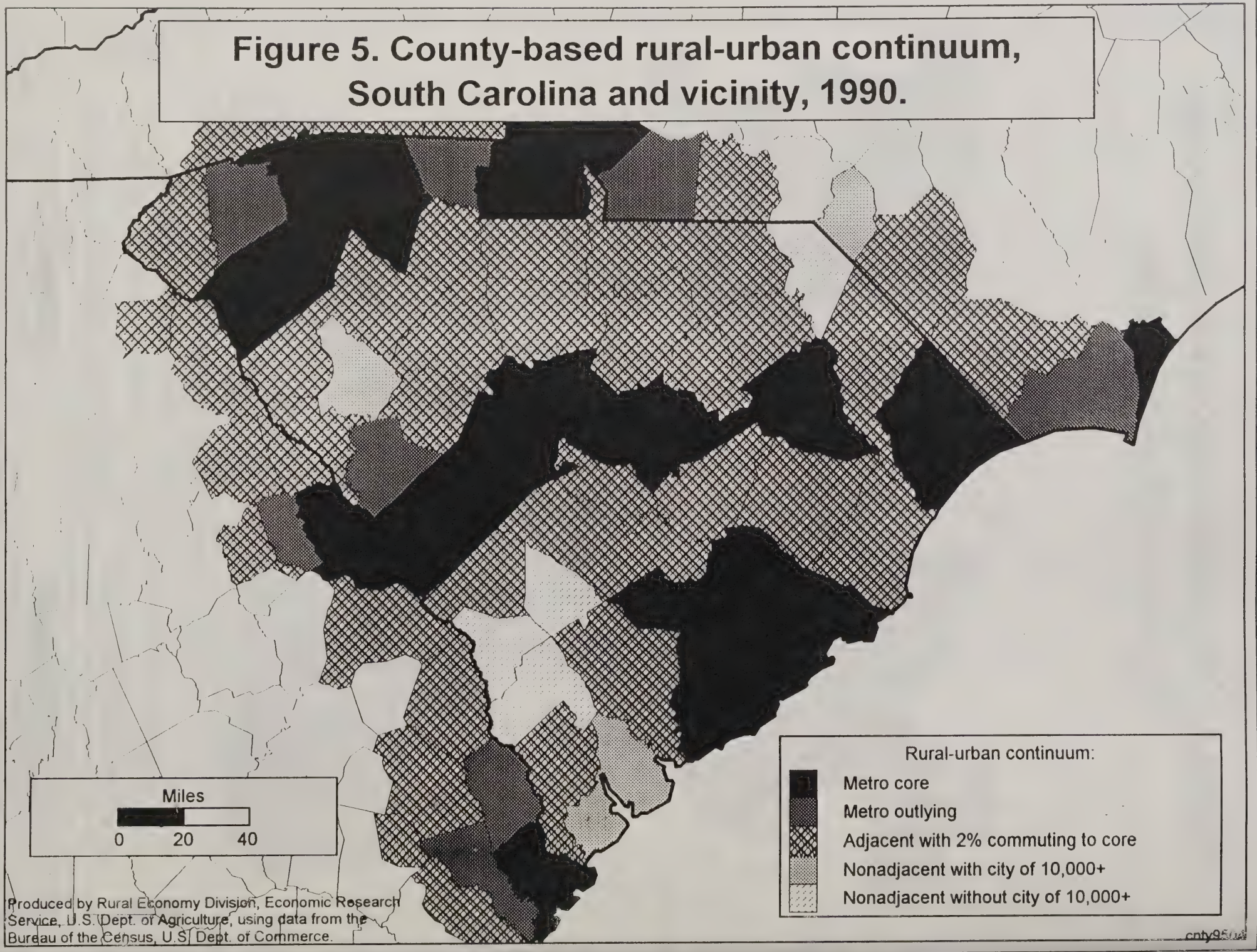
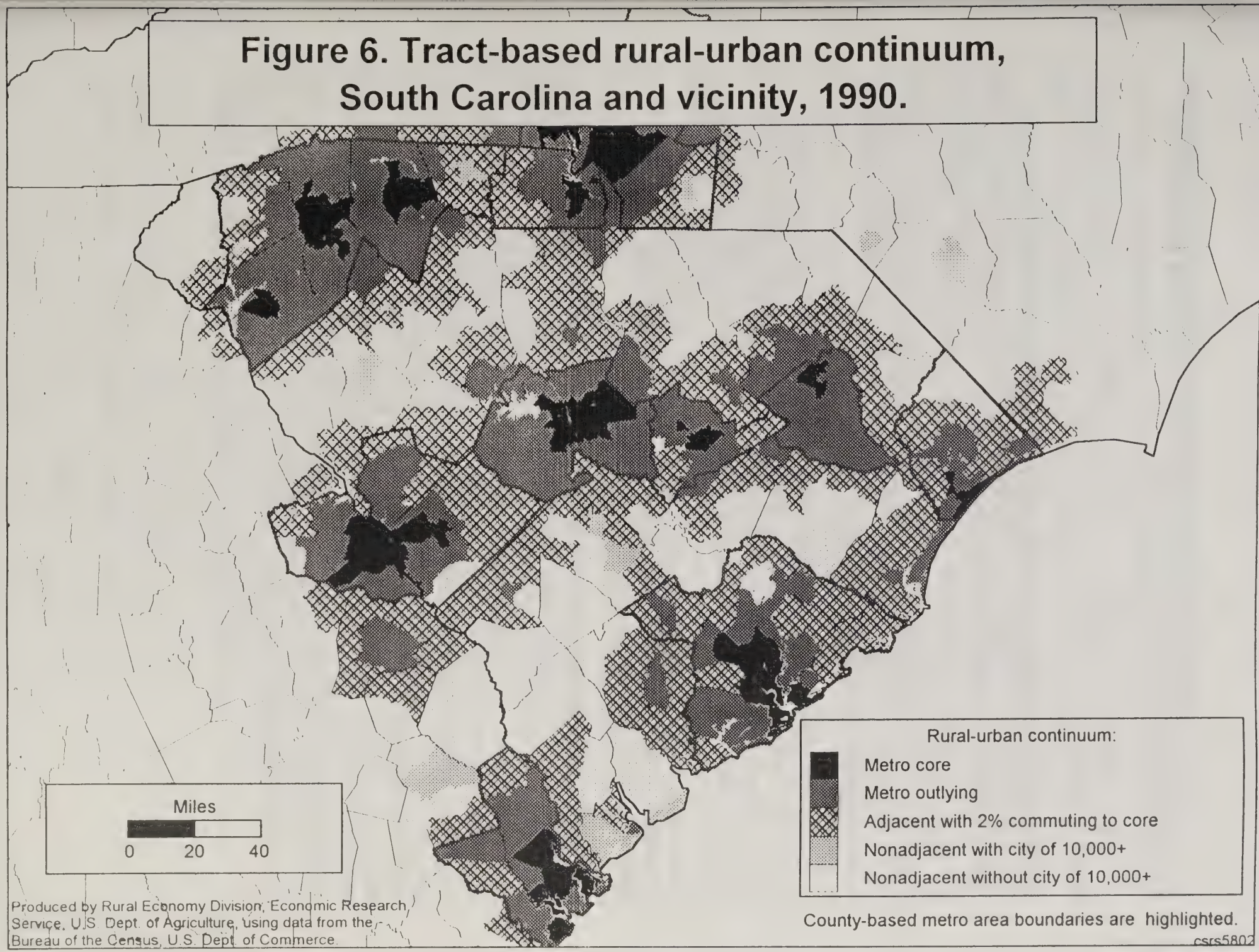


Figure 6. Tract-based rural-urban continuum, South Carolina and vicinity, 1990.



Produced by Rural Economy Division, Economic Research Service, U.S. Dept. of Agriculture, using data from the Bureau of the Census, U.S. Dept. of Commerce.

County-based metro area boundaries are highlighted.

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throughout the northern half of the State are much more clearly defined when tracts are used as the unit of measurement.

South Carolina

South Carolina's distributed urban structure---several medium-sized metro areas found throughout the State with no one dominant center---causes all but six of the State's nonmetro counties to be adjacent (figure 5). Only three metro counties are classified as outlying, totaling only 5 percent of the State's territory. Like Arizona, the county-based scheme gives no sense of the location of central cities and their relationship with outlying areas, both of which come into focus at the tract level (figure 6). Even in an Eastern State with relatively small counties, the rural-urban continuum looks completely different on the two maps.

In all nine metro areas shown, segments of the tract-based metro area reach beyond the county-based configurations into nonmetro territory. Some of these metro segments are noncontiguous, indicating a great deal of metro-nonmetro interpenetration. In all but two cases (Columbia and Florence), there are segments of the county-based metro area that are reclassified as nonmetro at the tract level. County-based metro areas are significantly overbounded in Augusta-Aiken, Charleston, and Myrtle Beach; the shape of the Myrtle Beach core changes completely to better represent its mostly coastal location.

All metro areas in South Carolina have a much different configuration of core and outlying territory. Outlying metro areas jump from 5 percent of the State's area at the county level to 26 percent at the tract level. This compares with only 6 percent metro outlying territory using tract-based measurement in both Arizona and Minnesota. As a result of South Carolina's wider distribution of metro population, adjacent areas are also more extensive than in the other two States (39 percent of the State's area, compared with 17 percent in Minnesota and 30 percent in Arizona). However, South Carolina's adjacent territory under tract-based measurement is not as extensive as in the county-based version shown in figure 5, where they make up 50 percent of the state's land area. South Carolina's tract-based map uncovers extensive areas not adjacent to metro regions, making up 30 percent of the State's territory, compared with only 10 percent in the county-based version.

Comparison of County- and Tract-Based Population and Territory [5]

When tracts are substituted for counties in creating the rural-urban continuum, the most commonly occurring change is for territory to shift by one category toward the rural end of the continuum. The loss of lower density territory makes proportionally little difference in the total population of metro areas. The metro territorial changes depicted in figures 1-6 are thus not paralleled by similarly large population changes. For the smaller populations in the nonmetro categories, however, the addition and loss of territory can make a sizeable percentage change in their population.

Arizona's metro population drops from 85 to 79 percent of the State total, a small decrease considering that metro territory drops from 36 percent to 8 percent of the State's total land area. The same trend occurs on a smaller scale in both Minnesota (dropping from 69 to 66 percent metro) and South Carolina (69 down to 68 percent metro). Switching from counties to tracts tightens the territorial boundaries that surround essentially the same metro population. This is illustrated by the changes in population density for metro cores, which jump from 135 to 1,298 people per square mile in Arizona, 228 to 1,556 in Minnesota, and 214 to 983 in South Carolina.

In Arizona, metro/nonmetro territorial shifts produced a 37 percent net increase in Arizona's relatively small nonmetro population. In part because Minnesota's and South Carolina's nonmetro populations were both more than a million using county-based measurement, the change in the nonmetro populations of these States was smaller, at 10 percent and 5 percent, respectively. However, small net change in the nonmetro population with tract-level measurement can mask large gross shifts. In South Carolina, for example, the 5 percent net increase was a result of an 18 percent addition of people from formerly metro territory, offset by a 13 percent loss of population living in territory that became metro.

The rearrangement of population within the nonmetro part of the rural-urban continuum toward the rural end of the hierarchy is also significant (table 1). In South Carolina, for instance, the population living in the most remote and rural category, nonadjacent nonmetro without a city, jumps from 76,000 with county measurement to over 500,000 with tract measurement. Similarly, population in this category more than doubles in Minnesota. Arizona saw a doubling in the population of nonadjacent areas with a city. This is because cities such as Kingman, Prescott, and the border cities of Nogales, Sierra Vista, and Douglas

[5]Statistics discussed in this section are shown in appendix tables 2-4.

were hidden in metro or adjacent counties but were visible as separate entities with tract-level classification.

In all three States, the population living in nonmetro territory adjacent to a metro area declines--in the case of Minnesota it drops by over 50 percent. But even the large net changes in adjacent population are much smaller than the gross shifts. A substantial portion of the tract-based adjacent population comes from areas that are metro in the county-based version. In Arizona, only 65,000 people fall in the

Table 1--Nonmetro population by the rural-urban continuum, comparing county- and tract-based classifications, 1990.

Rural-urban continuum categories[1]	County-based	Tract-based	Shared[2]
	1,000's		
Arizona:			
Adjacent	275	216	65
Nonadjacent, with city	97	213	31
Nonadjacent, without city	188	336	167
Minnesota:			
Adjacent	583	266	167
Nonadjacent, with city	389	364	232
Nonadjacent, without city	393	877	391
South Carolina:			
Adjacent	842	521	361
Nonadjacent, with city	146	96	65
Nonadjacent, without city	76	501	74

[1]The nonmetro rural-urban continuum categories are:
Adjacent: Physically adjacent to a metro area, 2 percent of working residents commute to a metro core.
Nonadjacent with city: Not physically adjacent to a metro area, contains all or part of a city of 10,000 people or more.
Nonadjacent without city: Not physically adjacent to a metro area, contains no part of a city of 10,000 people or more.
[2]Number of people in the same rural-urban category under both county-based and tract-based classifications.
Population data for metro components are in appendix table 2.

Source: ERS analysis of 1990 Decennial Census data, U.S. Bureau of the Census.

adjacent category in both the tract and county-based coding schemes, even though the tract and county-based schemes each show over 200,000 people in the adjacent category. In all three States, the territory and the populations making up the adjacent and nonadjacent with city categories shift dramatically.

Comparison of County- and Tract-Based Population Characteristics

Metro and nonmetro populations differ along important socioeconomic lines. For instance, nonmetro people are less likely to hold a college degree, are less likely to be in managerial or professional occupations, and are more likely to be poor. We compared county-based and tract-based metro-nonmetro differences for eight socioeconomic indicators that typically diverge between metro and nonmetro areas (table 2). For all but one of the chosen indicators (percent nonwhite), there was

Table 2--Changes in metro-nonmetro differences in population characteristics, when tracts are substituted for counties, 1990.

Population characteristics	Arizona	Minnesota	South Carolina
	metro-nonmetro differences larger (+) or smaller (-) at the tract level		
Percent:			
Nonwhite	-	+	-
Without a high school diploma	+	+	+
With a college degree	+	+	+
In farming, forestry, and fishing	+	+	+
In manufacturing	-	+	+
In finance, insurance, and real estate	+	+	+
In professional and managerial occupations	+	+	+
Living below the poverty level	-	+	+

*Metro-nonmetro difference at the county level is less than 2 percentage points.
This table is based on statistics shown in appendix tables 5-7.
Source: ERS analysis of 1990 Decennial Census data, U.S. Bureau of the Census

little metro/nonmetro difference in Minnesota. In Arizona and South Carolina, metro and nonmetro counties differed on all of the indicators measured. For five of the eight measures--percent without a high school diploma, percent with a college degree, percent working in the farming, forestry, or fishing industries, percent working in the finance, insurance, or real estate industries, and the percent working in professional or managerial occupations---the metro-nonmetro gap was wider at the tract level in all three States.

The consistent widening of existing differences between residents by type of settlement with tract-based measurement indicates an increased accuracy not only in territorial boundaries, but also in the identification of people by settlement type. For the most part, people who were shifted into the metro category in the tract-based measurement were more similar to people already in the metro category than they were to the people in the county-based nonmetro category; the same can be said for those who shifted into the nonmetro category.

Modifications Necessary for Tract-Based Measurement

To take this analysis beyond the pilot stage described in this paper to depict national settlement patterns, several modifications should be made. For illustrative purposes, we have applied the current criteria used to delineate metro areas. However, tract-based measurement at the national level would require that these criteria be examined in light of the scale differences between counties and tracts. One criterion that needs to be modified is the requirement that outlying metro areas exhibit "metropolitan character" based on population density, percentage urban, and population change. Many of the tracts that currently fall in the "nonmetro adjacent" category do not qualify as metro outlying because they failed the "metropolitan character" test, even though they have significant levels of commuting to the metro core, some higher than 50 percent. The idea that economic and social integration with the core should be based on commuting alone has been suggested by many over the years, including most recently Morrill (1991). The difficulty is deciding on a reasonable threshold, in terms of the percentage of the employed labor force commuting to the core, above which areas are deemed integrated. It may be argued that the minimum threshold of 15 percent in the current criteria using counties (which is also the threshold suggested by Morrill) could be adjusted upward to account for the smaller size of tracts, perhaps to 20 percent. This change in the criteria would result in an expansion of the metro outlying territory from what is currently depicted in figures 2, 4, and 6.

Another needed change involves measuring integration based on commuting from the core as well as commuting to the core. Uncovering the discontinuities in

settlement patterns is one of the great advantages of using tracts over counties, given the development of satellite employment centers and far-flung bedroom communities, areas that are economically tied but not physically adjacent to the metro cores. It is what Alonso (1992) was referring to when he described the "fine-grained interpenetration" of settlement patterns. However, it is necessary to re-think the use of commuting flows in both directions. Small numbers of long-distance commuters from metro cores to far-flung nonmetro tracts result in the inclusion of these tracts in the metro area. Given that the question producing the commuting data asks only where the person worked "last week," this calculation may generate anomalies when small areas are used.

Modification of criteria, selective relaxation of assumptions, and the determination of the final set of criteria that best fits tract-level analysis is necessary to develop this sub-county system of measuring national settlement patterns. As with any set of criteria used to delineate statistical areas, no single test exists to determine the "best fit." Rather, the selected criteria and the resulting statistical areas are determined to be more accurate reflections of settlement patterns based on the objectives sought and the knowledge of experts familiar with the variables used. We expect a new set of criteria for delineating the rural-urban continuum that may eventually be applied to the Nation as a whole.

Conclusions

To understand the complete system of U.S. settlement, a rural-urban continuum is crucial. Existing ERS continuums provide a reliable base on which to build. The choice of geographic units affects both the accuracy of the continuum and the ability to implement the system with a diverse set of data. Applying currently used criteria to sub-county data more accurately reflects the territorial divisions along the continuum from the largest cities to open country. The shortcomings of the current system seem to be largely a function of the use of counties as the units of analysis and the lack of attention to the nonmetro part of the spectrum.

The maps resulting from the application of current criteria to sub-county data for three States outline more precisely the territorial division between metro and nonmetro areas than is possible with counties. A tract-based measurement system also reveals the diversity of population and settlement patterns within nonmetro territories. The geographical gradations from one end of the rural-urban continuum to the other are brought into focus with the use of tracts, especially the role of metro-adjacent areas as transition zones between settlement types. If trends of the last few decades continue, metro-adjacent territory will be among the fastest growing in the near future, both in employment and residential population.

We have shown that the people living in the territories that shifted from nonmetro to metro or vice versa are, in many of the characteristics that differentiate metro and nonmetro people, more like those in their new category than their old one. Programs designed to target residents of specific types of settlement areas could be more accurately implemented with sub-county delineation. With the earlier-mentioned modifications to metro definition necessary for the smaller populations of tracts and the application of the tract-based rural-urban continuum to the balance of States, a system would be in place enabling more accurate identification of patterns of emerging centers and specific areas of loss, both in and around metro areas and in small cities and towns.

References

Adams, J. 1995. "Classifying settled areas of the United States: Conceptual issues and proposals for new approaches," in *Metropolitan and Nonmetropolitan Areas: New Approaches to Geographical Definition.* Eds. D. Dahmann and J. Fitzsimmons. U.S. Dept. of Commerce, Bureau of the Census, Population Division, Working Paper No. 12.

Alonso, W. 1992. "The Interpenetration of Rural and Urban America." in *Population Change and the Future of Rural America: A Conference Proceedings*, edited by L. Swanson and D. Brown, U.S. Dept. of Agriculture, Economic Research Service, Staff Report No. AGES 9324.

Berry, B. 1995. "Capturing evolving realities: statistical areas for the American future," in *Metropolitan and Nonmetropolitan Areas: New Approaches to Geographical Definition.* Eds. D. Dahmann and J. Fitzsimmons. U.S. Dept. of Commerce, Bureau of the Census, Population Division, Working Paper No. 12.

Butler, M., and C. Beale. 1994. *Rural-Urban Continuum Codes for Metro and Nonmetro Counties, 1993.* U.S. Dept. of Agriculture, Economic Research Service. Staff Report No. AGES 9425.

Dahmann, D., and J. Fitzsimmons (Eds.). 1995. *Metropolitan and Nonmetropolitan Areas: New Approaches to Geographical Definition.* U.S. Dept. of Commerce, Bureau of the Census, Population Division. Working Paper No. 12.

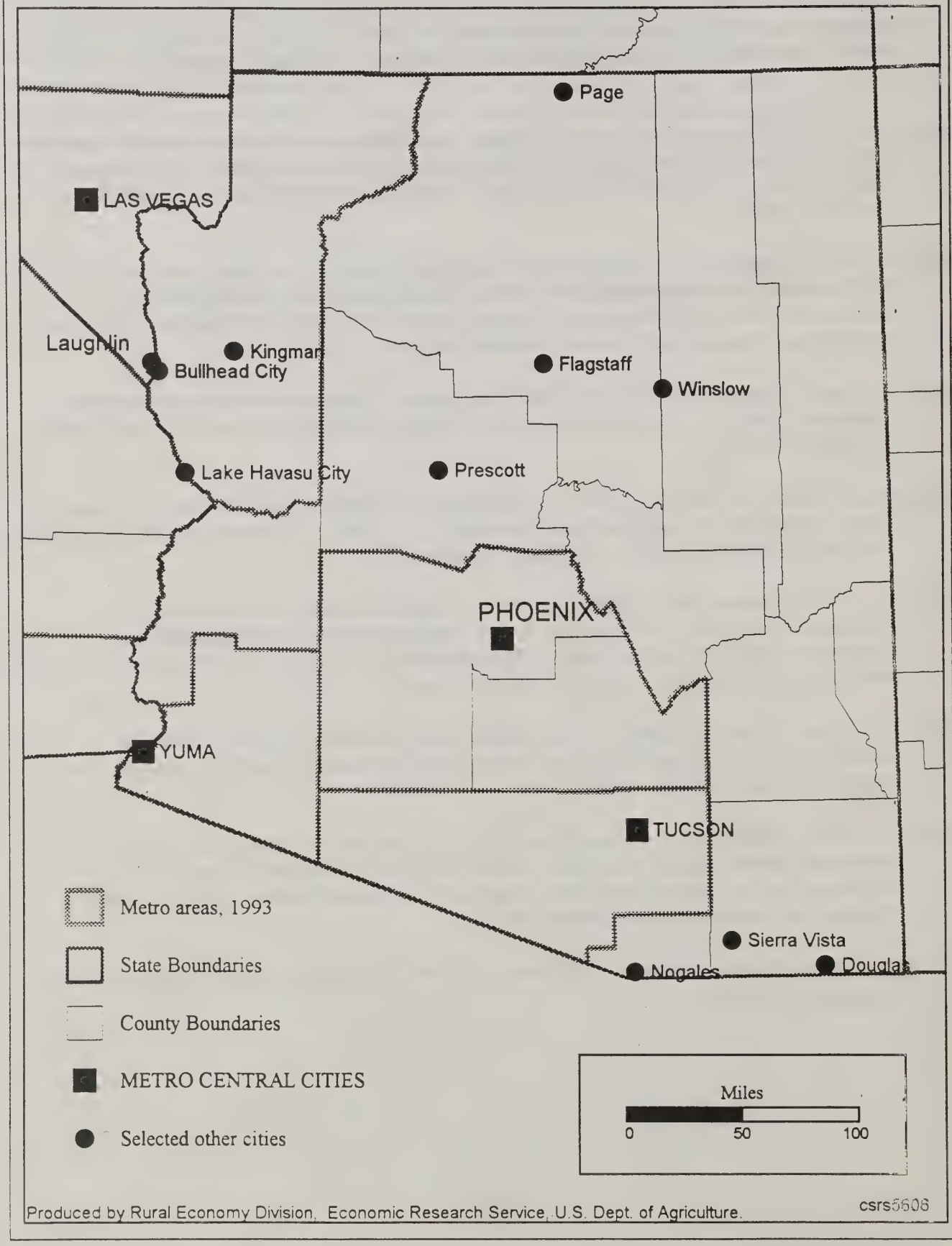
Frey, W., and A. Speare. 1995. "Metropolitan areas as functional communities," in *Metropolitan and Nonmetropolitan Areas: New Approaches to Geographical Definition.* Eds. D. Dahmann and J. Fitzsimmons. U.S. Dept. of Commerce, Bureau of the Census, Population Division. Working Paper No. 12.

Ghelfi, L.M., and T. Parker. 1995. "A new county-level measure of urban influence." Presented at the annual meeting of the Rural Sociological Society, Pentagon City, Virginia, August 17-20.

Morrill, R. 1995. "Metropolitan concepts and statistics report," in *Metropolitan and Nonmetropolitan Areas: New Approaches to Geographical Definition.* Eds. D. Dahmann and J. Fitzsimmons. U.S. Dept. of Commerce, Bureau of the Census, Population Division. Working Paper No. 12.

U.S. Dept. of Commerce, Bureau of the Census. 1994. *Geographic Areas Reference Manual.* Geography Division.

Appendix figure 1--Arizona and vicinity



Produced by Rural Economy Division, Economic Research Service, U.S. Dept. of Agriculture.

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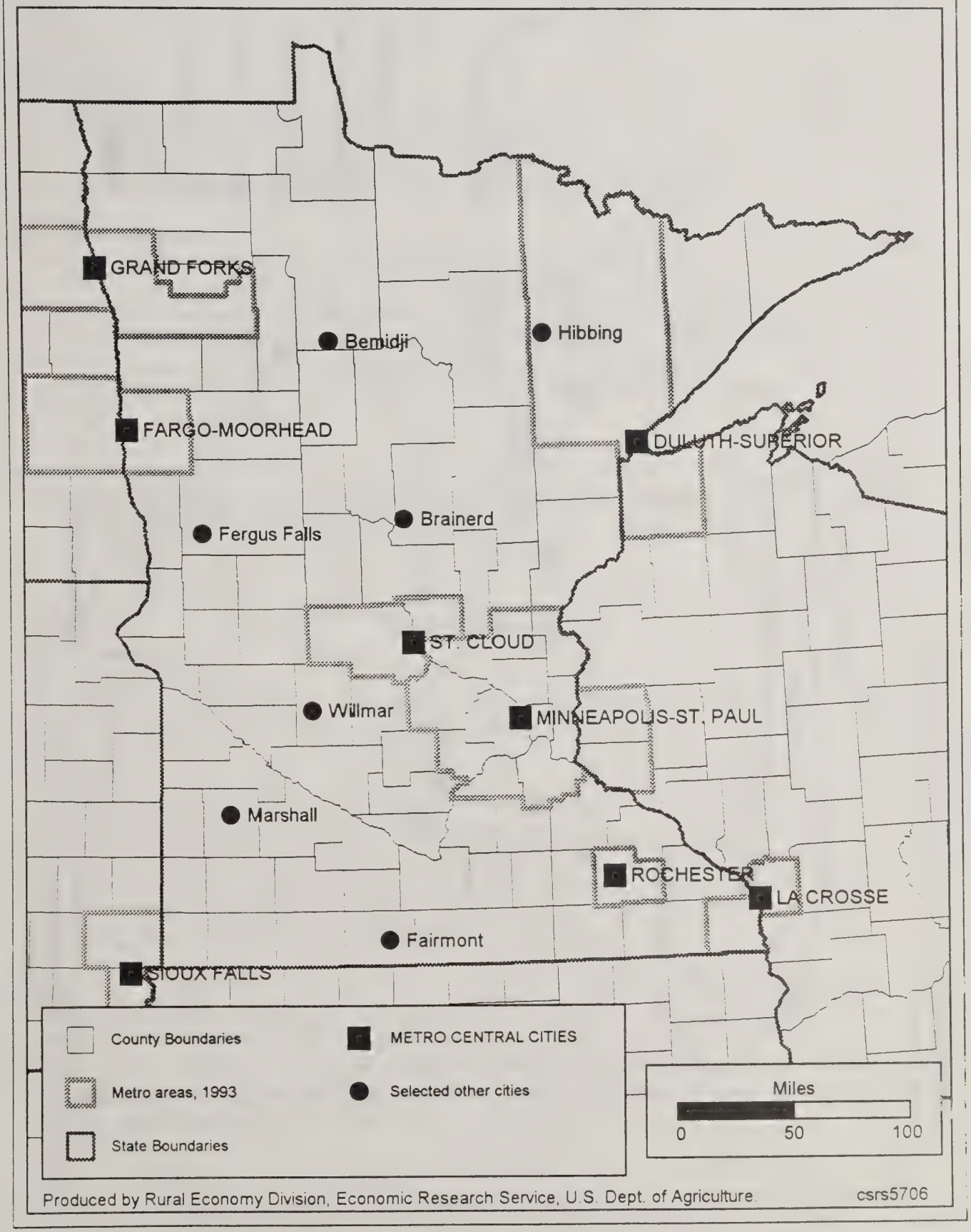
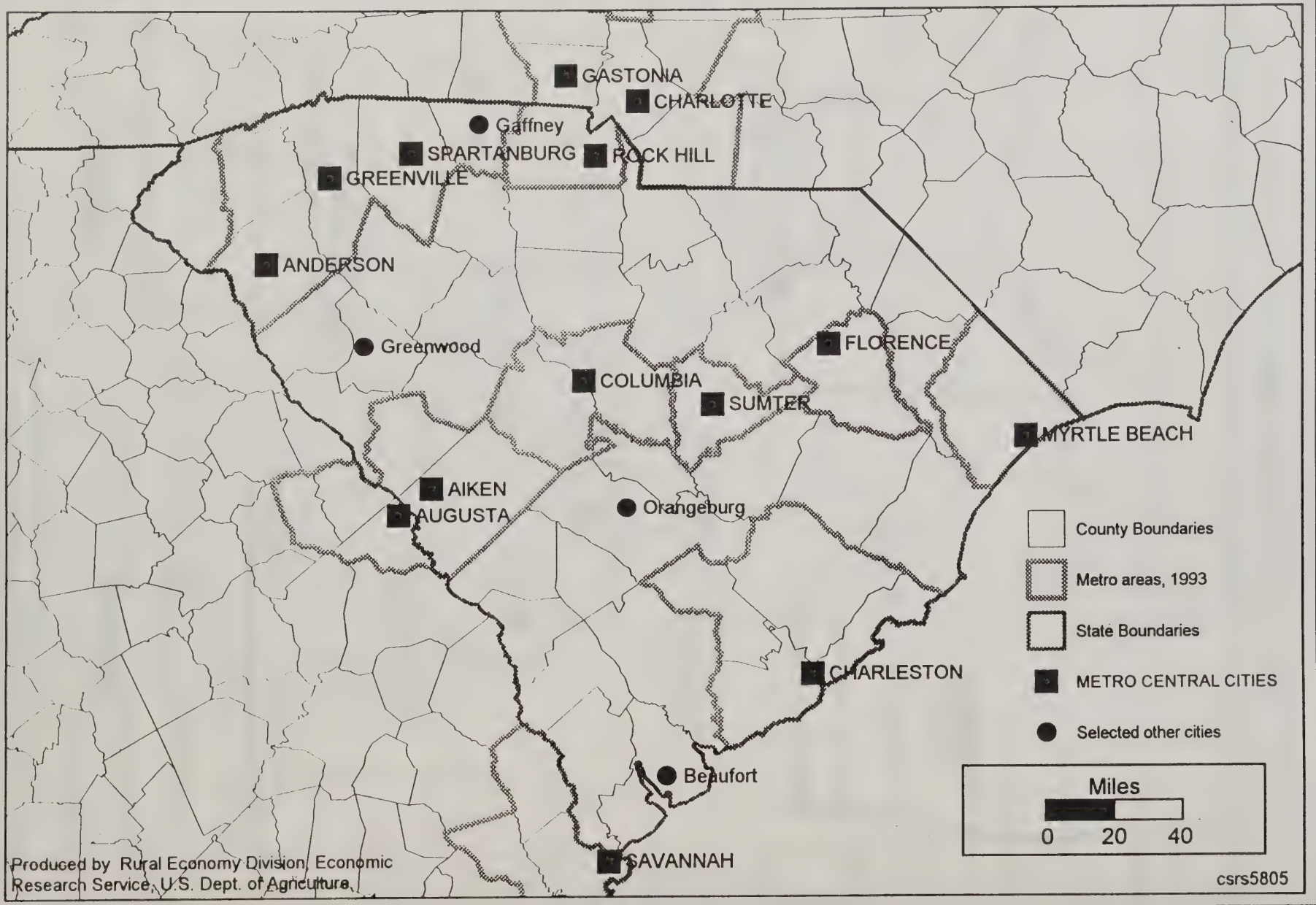
Appendix figure 2--Minnesota and vicinity



Appendix figure 3--South Carolina and vicinity



Appendix table 1--County identification codes created by the Economic Research Service, USDA.

Rural-Urban Continuum Code

Metro counties:

0.....Central counties of metro areas of 1 million+
1.....Fringe counties of metro areas of 1 million+
2.....Counties in metro areas of 250,000 - 1 million population
3.....Counties in metro areas of fewer than 250,000 population

Nonmetro counties:

4.....Urban population of 20,000+, adjacent to metro area
5.....Urban population of 20,000+, not adjacent to metro area
6.....Urban population of 2,500 - 19,999, adjacent to metro area
7.....Urban population of 2,500 - 19,999, not adjacent to metro area
8.....Less than 2,500 urban population, adjacent to metro area
9.....Less than 2,500 urban population, not adjacent to metro area

Source: Butler, M., and C. Beale. 1994. *Rural-Urban Continuum Codes for Metro and Nonmetro Counties, 1993*. U.S. Dept. of Agriculture, Economic Research Service. Staff Report No. AGES 9425.

Urban Influence Code

Metro counties:

1.....Large, 1 million+ population in total metro area
2.....Small, less than 1 million population in metro area

Nonmetro counties:

3.....Adjacent to large metro area, with own city*
4.....Adjacent to large metro area, without own city
5.....Adjacent to small metro area, with own city
6.....Adjacent to small metro area, without own city
7.....Not adjacent to metro area, with own city
8.....Not adjacent to metro area, without own city

*Own city indicates that the county contains all or part of a city with 10,000+ population

Source: Ghelfi, L.M., and T. Parker. 1995. "A new county-level measure of urban influence." Presented at the annual meeting of the Rural Sociological Society, Pentagon City, Virginia, August 17-20.

Appendix table 2--Population by the rural-urban continuum, comparing county- and tract-based classifications, 1990

Rural-urban continuum categories[1]	County-based		Tract-based	
	Population	Share of State total	Population	Share of State total
	1,000s	Percent	1,000's	Percent
Arizona:				
Metro	3,105.8	84.7	2,900.6	79.1
Core	2,895.9	79.0	2,663.1	72.7
Outlying	209.9	5.7	237.5	6.5
Nonmetro	559.5	15.3	764.7	20.9
Adjacent	275.2	7.5	216.0	5.9
Nonadjacent with city	96.6	2.6	212.9	5.8
Nonadjacent without city	187.7	5.1	335.8	9.2
Minnesota:				
Metro	3,010.9	68.8	2,868.5	65.6
Core	2,687.0	61.4	2,382.5	54.5
Outlying	323.9	7.4	486.0	11.1
Nonmetro	1,364.2	31.2	1,506.6	34.4
Adjacent	583.0	13.3	266.0	6.1
Nonadjacent with city	388.7	8.9	363.7	8.3
Nonadjacent without city	392.5	9.0	877.0	20.0
South Carolina:				
Metro	2,422.6	69.5	2,369.1	67.9
Core	2,265.8	65.0	1,463.3	42.0
Outlying	156.8	4.5	905.8	26.0
Nonmetro	1,064.1	30.5	1,117.6	32.1
Adjacent	841.9	24.1	521.2	14.9
Nonadjacent with city	146.0	4.2	95.5	2.7
Nonadjacent without city	76.2	2.2	500.9	14.4

[1]The rural-urban continuum categories are:

Metro core: Central places of 50,000 people or more and adjacent densely-settled surrounding territory.

Metro outlying: Highly integrated with metro cores, as measured by commuting flows.

Nonmetro adjacent: Physically adjacent to a metro area, 2 percent of working residents commute to a metro core.

Nonmetro nonadjacent with city: Not physically adjacent to a metro area, contains all or part of a city of 10,000 people or more.

Nonmetro nonadjacent without city: Not physically adjacent to a metro area, contains no part of a city of 10,000 people or more.

Source: ERS analysis of 1990 Decennial Census data, U.S. Bureau of the Census.

Appendix table 3--Land area by the rural-urban continuum, comparing county- and tract-based classifications, 1990

Rural-urban continuum categories[1]	County-based		Tract-based	
	Land area	Share of State total	Land area	Share of State total
	Square miles	Percent	Square miles	Percent
Arizona:				
Metro	40,198	36.1	8,472	7.6
Core	21,521	19.3	2,051	1.8
Outlying	18,677	16.8	6,421	5.8
Nonmetro	71,034	63.9	102,760	92.4
Adjacent	20,299	18.2	33,252	29.9
Nonadjacent with city	18,610	16.7	6,292	5.7
Nonadjacent without city	32,125	28.9	63,216	56.8
Minnesota:				
Metro	16,974	21.3	6,398	8.0
Core	11,776	14.8	1,531	1.9
Outlying	5,197	6.5	4,867	6.1
Nonmetro	62,641	78.7	73,216	92.0
Adjacent	22,616	28.4	13,774	17.3
Nonadjacent with city	10,654	13.4	3,784	4.7
Nonadjacent without city	29,371	36.9	55,658	69.9
South Carolina:				
Metro	11,986	40.0	9,391	31.3
Core	10,594	35.3	1,489	5.0
Outlying	1,392	4.6	7,902	26.4
Nonmetro	17,995	60.0	20,590	68.7
Adjacent	15,111	50.4	11,623	38.8
Nonadjacent with city	1,043	3.5	452	1.5
Nonadjacent without city	1,841	6.1	8,515	28.4

[1]The rural-urban continuum categories are:

Metro core: Central places of 50,000 people or more and adjacent densely-settled surrounding territory.

Metro outlying: Highly integrated with metro cores, as measured by commuting flows.

Nonmetro adjacent: Physically adjacent to a metro area, 2 percent of working residents commute to a metro core.

Nonmetro nonadjacent with city: Not physically adjacent to a metro area, contains all or part of a city of 10,000 people or more.

Nonmetro nonadjacent without city: Not physically adjacent to a metro area, contains no part of a city of 10,000 people or more.

Source: ERS analysis of 1990 Decennial Census data, U.S. Bureau of the Census.

Appendix table 4--Population density by the rural-urban continuum, comparing county- and tract-based classifications, 1990

Rural-urban continuum categories[1]	County-based	Tract-based
	People per square mile	
Arizona:		
Metro	77.3	342.4
Core	134.6	1,298.2
Outlying	11.2	37.0
Nonmetro	7.9	7.4
Adjacent	13.6	6.5
Nonadjacent with city	5.2	33.8
Nonadjacent without city	5.8	5.3
Minnesota:		
Metro	177.4	448.3
Core	228.2	1,555.8
Outlying	62.3	99.9
Nonmetro	21.8	20.6
Adjacent	25.8	19.3
Nonadjacent with city	36.5	96.1
Nonadjacent without city	13.4	15.8
South Carolina:		
Metro	202.1	252.3
Core	213.9	982.6
Outlying	112.7	114.6
Nonmetro	59.1	54.3
Adjacent	55.7	44.8
Nonadjacent with city	140.0	211.2
Nonadjacent without city	41.4	58.8

[1]The rural-urban continuum categories are:

Metro core: Central places of 50,000 people or more and adjacent densely-settled surrounding territory.

Metro outlying: Highly integrated with metro cores, as measured by commuting flows.

Nonmetro adjacent: Physically adjacent to a metro area, 2 percent of working residents commute to a metro core.

Nonmetro nonadjacent with city: Not physically adjacent to a metro area, contains all or part of a city of 10,000 people or more.

Nonmetro nonadjacent without city: Not physically adjacent to a metro area, contains no part of a city of 10,000 people or more.

Source: ERS analysis of 1990 Decennial Census data, U.S. Bureau of the Census.

Appendix table 5--Characteristics of metro and nonmetro residents of **Arizona** as measured with counties and census tracts, 1990

Population characteristics	County-based		Tract-based	
	Metro	Nonmetro	Metro	Nonmetro
Total population	3,105,752	559,476	2,900,552	764,676
Pct. nonwhite	16.9	31.7	16.5	29.2
Poverty population[1]	3,044,326	540,073	2,841,293	743,106
Pct. in poverty	14.1	25.1	13.5	24.3
Population age 25 +	1,969,470	331,707	1,837,123	464,054
Pct. without H.S. diploma	20.1	28.6	19.2	29.9
Pct. with college degree	28.1	21.2	29.1	19.4
Employed pop. age 16 +	1,410,689	193,207	1,334,900	268,996
Pct. agriculture, forestry, fisheries, and mining industries	2.9	7.0	2.5	7.7
Pct. manufacturing industry	13.6	7.2	13.8	8.1
Pct. FIRE[2] industries	8.0	4.0	8.2	4.1
Pct. managerial or professional specialty occupations	27.3	23.7	27.8	22.1

[1]Poverty population excludes unrelated individuals under age 15.
[2]Finance, insurance, and real estate

Appendix table 6--Characteristics of metro and nonmetro residents of **Minnesota** as measured with counties and census tracts, 1990

Population characteristics	County-based		Tract-based	
	Metro	Nonmetro	Metro	Nonmetro
Total population	3,010,894	1,364,205	2,868,488	1,506,611
Pct. nonwhite	7.0	2.5	7.2	2.5
Poverty population[1]	2,940,305	1,319,151	2,801,279	1,458,177
Pct. in poverty	8.8	13.3	8.6	13.3
Population age 25+	1,903,407	867,155	1,809,746	960,816
Pct. without H.S. diploma	14.0	25.7	13.4	25.6
Pct. with college degree	34.4	21.5	35.2	21.2
Employed pop. age 16+	1,585,637	606,780	1,528,012	664,405
Pct. agriculture, forestry, fisheries, and mining industries	2.1	11.0	1.3	11.9
Pct. manufacturing industry	18.1	18.5	18.3	18.0
Pct. FIRE[2] industries	7.7	4.0	7.8	3.9
Pct. managerial or professional specialty occupations	28.6	19.8	29.1	19.5

[1]Poverty population excludes unrelated individuals under age 15.
[2]Finance, insurance, and real estate

Appendix table 7--Characteristics of metro and nonmetro residents of **South Carolina** as measured with counties and census tracts, 1990.

Population characteristics	County-based		Tract-based	
	Metro	Nonmetro	Metro	Nonmetro
Total population	2,422,615	1,064,088	2,369,089	1,117,614
Pct. nonwhite	26.7	40.8	26.9	39.5
Poverty population[1]	2,331,167	1,036,958	2,275,408	1,092,717
Pct. in poverty	13.4	19.8	13.1	20.0
Population age 25 +	1,510,224	657,366	1,478,189	689,401
Pct. without H.S. diploma	28.7	38.7	28.1	39.5
Pct. with college degree	25.3	17.5	25.7	17.2
Employed pop. age 16 +	1,144,872	458,553	1,120,461	482,964
Pct. agriculture, forestry, fisheries, and mining industries	1.8	3.7	1.7	3.9
Pct. manufacturing industry	22.7	33.1	22.4	33.3
Pct. FIRE[2] industry	5.6	3.8	5.8	3.5
Pct. managerial or professional specialty occupations	24.0	17.3	24.2	17.1

[1]Poverty population excludes unrelated individuals under age 15.
[2]Finance, insurance, and real estate